



South Fork Rivanna Reservoir and Watershed

Reflecting on 36 Years, Anticipating 50 years

EXPANDED SUMMARY

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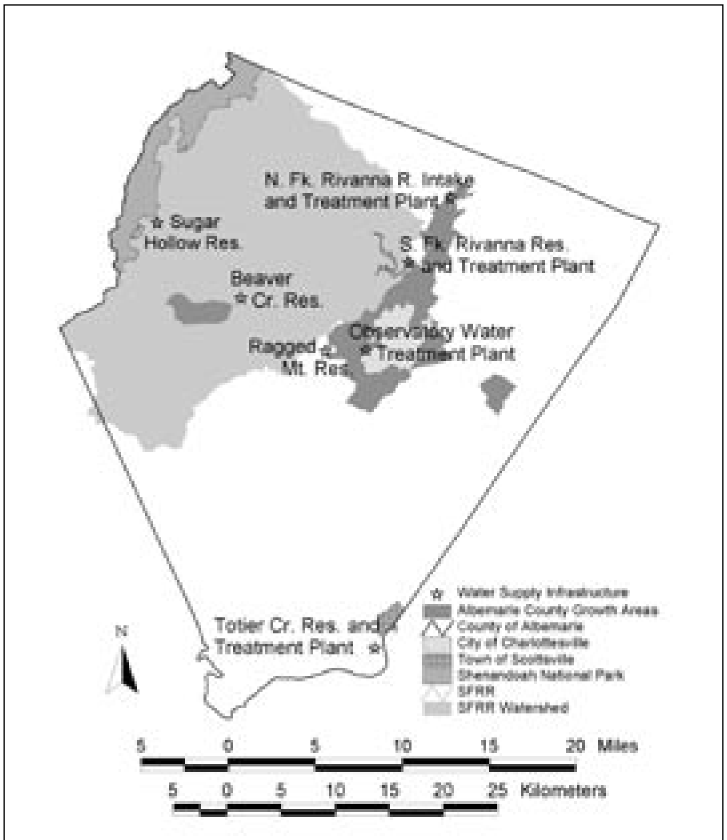
✧ INTRODUCTION

The purpose of this report is to review the 36 year history of the South Fork Rivanna Reservoir (SFRR) and the 23 year history of active watershed management with an eye toward developing a new watershed management plan to protect water resources. The last watershed management plan for SFRR was developed in 1979. The community is currently engaged in a Water Supply Project with a planning horizon of 30 to 50 years. All indications are that the SFRR will remain the dominant water source for years to come.

It is time to revisit the 1979 plan in order to adapt to changes and develop new strategies to address the unsolved challenges. The reservoir water quality issues are both different from and similar to those faced 23 years ago. Water quality, the watershed landscape, drinking water regulations, and watershed management techniques have all changed. At the same time, sedimentation rates and development rates have remained stubbornly persistent. The community must learn from and build upon the watershed management efforts of the past to avoid putting the SFRR at increased risk of water quality and quantity problems just as we are putting more emphasis on it as a water supply.



Major elements of the public water supply system for the City of Charlottesville and Albemarle County. The City and the County Development Areas are served by the system.

✧ SOUTH FORK RIVANNA CHARACTER AND ECOLOGY

The SFRR is a long, narrow water body with a very large watershed giving it the characteristics of both a river and a lake. The result is a relatively consistent water supply, but also large pollutant loads and management challenges. Many of the problems with the SFRR are related to the very thing that makes it a useful water supply — its ability to hold back water. The increased water residence time

How does the SFRR fit into the water system?

The SFRR is the largest water source for the 82,000 people using public water in the City of Charlottesville and urban Albemarle County. SFRR water is treated near the reservoir at the South Fork Rivanna Water Treatment Plant. Water for the urban system also comes from the Sugar Hollow Reservoir on the Moormans River near White Hall and the Ragged Mountain Reservoirs southwest of Charlottesville. Water from these reservoirs is treated at the Observatory Water Treatment Plant near UVA. The northern portion of Albemarle County's Designated Development Area is served by an intake on the North Fork Rivanna River with its own water treatment plant. Chris Greene Lake serves as a back-up supply for this plant. Crozet receives water from the Beaver Creek Reservoir that is treated at a nearby plant. Both the Sugar Hollow and Beaver Creek Reservoirs are nested within the SFRR Watershed. Scottsville is served by a local source, the Totier Creek Reservoir, and a local water treatment plant. Residents of Albemarle County who are not served by public water use groundwater from private or community wells. Well users who live in the SFRR Watershed have an influence on SFRR water and their water comes from the same hydrologic system, though they do not drink SFRR water in their homes.

relative to the natural river provides storage for drinking water but also allows pollutants to be trapped.

The watershed falls almost entirely within the County of Albemarle, putting prime responsibility for its care in local hands. As of the early 1990s, the watershed was 73% forested (the best land use for water quality). However, much of the watershed alteration that threatens water quality, as reflected by increased acreage of roads, driveways, rooftops and lawns, appears to have occurred along the tributaries closest to the reservoir.

A major issue is sedimentation, which causes an average annual rate of loss in drinking water storage capacity of 1.1%. Sedimentation is a natural process accelerated by human activities. Over-enrichment (eutrophication), another human acceleration of a natural process, is an additional problem in the reservoir. Eutrophication is not extreme (as it probably was in the 1970s) but is important to keep at a minimum. Weather conditions at both extremes (dry and wet) exacerbate reservoir problems. The watershed as an ecosystem has characteristics that provide natural water quality protection or resilience. These features need to be protected and enhanced wherever possible. They include the forests (particularly the streamside forests), wetlands, and the stream network.

Watershed Management History and Issues

The local community has done a great deal to protect the SFRR over the years making it a regional leader in watershed protection. Highlights include multiple studies of the reservoir, the 1979 management plan, creation of a full-time staff position, a major land use down-zoning, and development of ordinances to deal with stormwater, erosion control, and stream buffer protection. There have also been changes at the state and federal level that have benefited the SFRR.

What is ecosystem resilience?

Ecosystems, including watersheds, have natural characteristics that confer a degree of protection to the ecosystem and those who rely on it. These protective characteristics sometimes are referred to as “resilience.” The logic is similar to the idea that general good health in people provides them protection from illness. As long as the protective characteristics are preserved, the natural ecosystem is somewhat resilient to natural disturbances, such as hurricanes and forest fires, and human caused disturbances, such as pollution and development. In this way, the ecosystem’s natural resilience provides a service to the human community by protecting the resources that people rely on the ecosystem to provide, such as clean water or fertile soil. If those protective characteristics are destroyed, resilience is reduced, and the ecosystem becomes much more “brittle” or susceptible to problems.

The most important and obvious source of resilience in the SFRR Watershed ecosystem is natural forest. Forests produce the cleanest flow of water possible. The leaves of the forest intercept rainwater dissipating its energy so that it doesn’t dislodge soil upon impact and cause pollution, stream bank erosion, and flooding. The fallen leaves and branches and root systems of the trees slow and trap water that might otherwise run along the surface of the ground, increase storm flows, and cause erosion. Growing plants in the forest take up nutrients from the water that otherwise could enter a waterway as pollution. The organic material of the forest floor binds and traps nutrients and other chemicals. The forest ecosystem can process these materials or sequester them long enough to reduce the impacts to the reservoir.

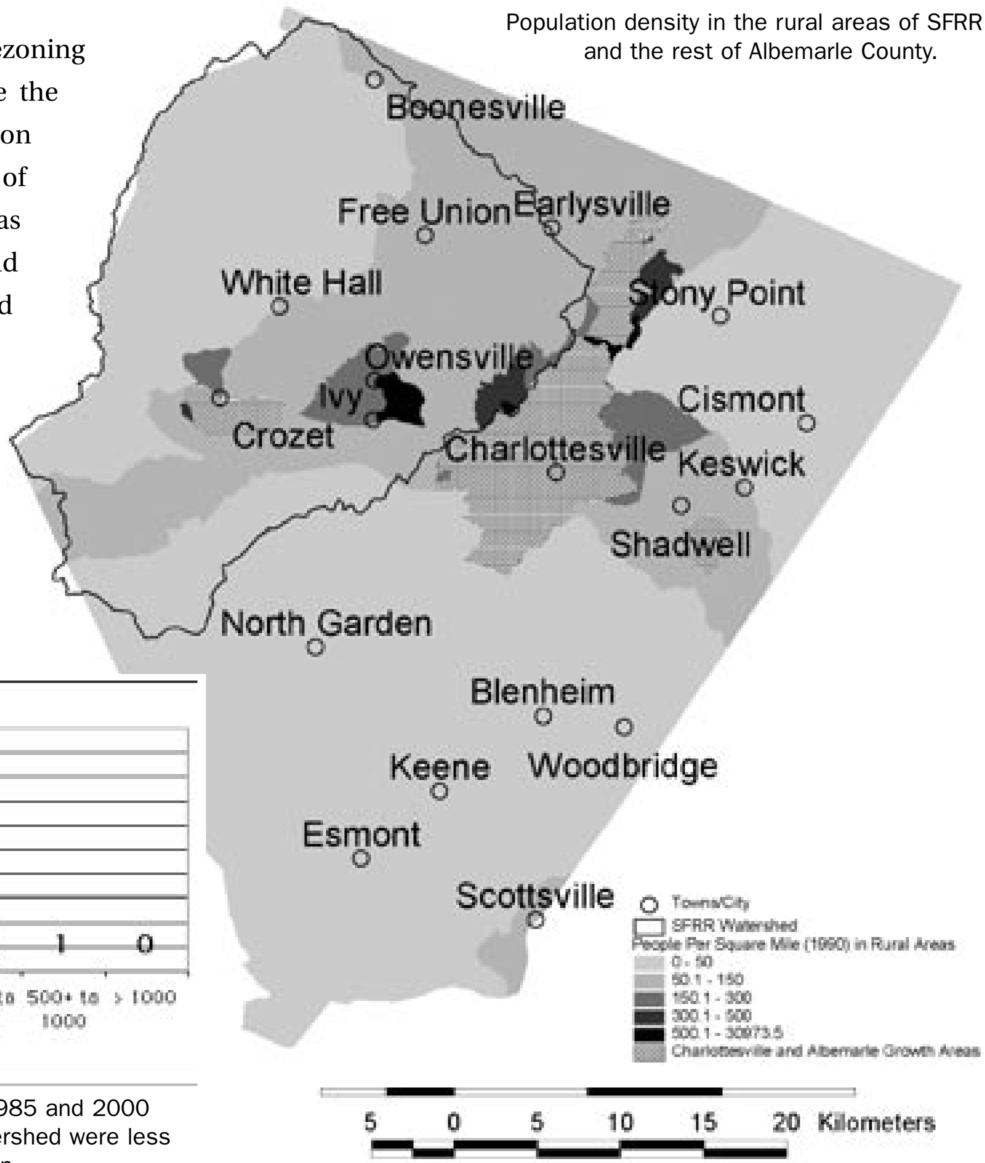
Healthy, relatively undisturbed soils enhance the reliability of the reservoir system. These soils tend to encourage more water to soak into the ground, particularly in cool months. Much of that groundwater will become stream flow at a later time, adding storage capacity to the watershed that supplements the limited storage in the reservoir itself. One can think of the water stored in the ground for long periods of time as the principal of a bank account, while the water in the reservoir at any moment is short-term interest.

Reservoir and Watershed Changes

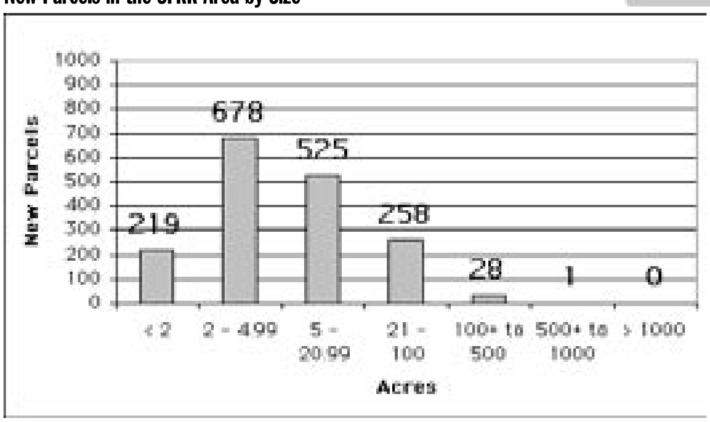
✧ Land Use

The stated justification of the 1980 rezoning effort was that it would help to achieve the complementary goals of rural preservation and water quality protection. In spite of the rezoning and policy changes, there has been a pattern of conversion of rural land to suburban land use. The trend is toward relatively small parcels and a decline in farm acreage. The SFRR Watershed has a growth rate higher than average for designated rural areas but somewhat lower than designated growth areas.

Population density in the rural areas of SFRR and the rest of Albemarle County.



New Parcels in the SFRR Area by Size



The majority of new parcels created between 1985 and 2000 in the rural areas approximating the SFRR Watershed were less than five acres in size indicating suburbanization.

SFRR Management Timeline

1962 SFRR land purchased by City of Charlottesville.

1966 Reservoir filled and water production begins.

1968 First Albemarle Zoning Ordinance allows high density near SFRR.

1969 Four fish kills in the reservoir, probably due to low dissolved oxygen at night.

1970 Reservoir closed for two weeks after fish kill attributed to Endrin discharge at Crown Orchards.

1972 Rivanna Water and Sewer Authority (RWSA) formed.

Fish kill in Lickinghole Creek attributed to ammonia spill at Morton Frozen Foods.

Clean Water Act creates National Pollutant Discharge Elimination System, requiring reduction in discharge of common, point source pollutants.

1973 RWSA forms advisory committee on reservoir management.

1974 City asks Albemarle to lower zoning density near SFRR.

UVA says SFRR is “sick.”

1975 EPA concludes that “accelerated pollution” is occurring, suggests point source interceptor.

Albemarle adopts first “Soil Erosion and Sedimentation Ordinance.”

State Water Control Board (SWCB) and Virginia Department of Health (VDH) urge protecting quality of SFRR.

Temporary moratorium on intensive development.

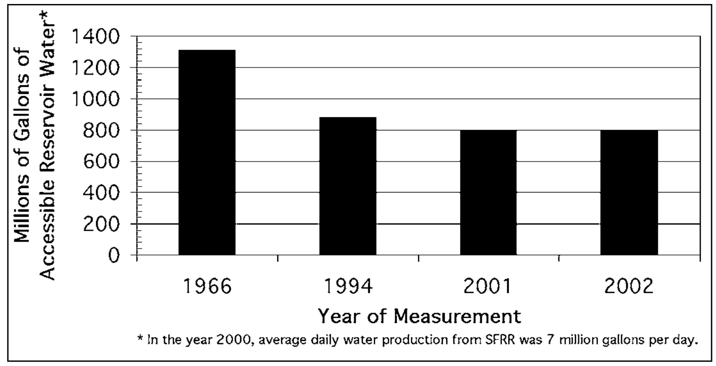
First reservoir study begins.

1977 Albemarle Supervisors adopt “Runoff Control Ordinance” for water supply watersheds to attempt to control phosphorus and sediment pollution.

✧ SEDIMENTATION

Sediment loads have varied greatly over the years, probably as a result of the occurrence of large storm events such as hurricanes. However, the amount of sediment generated relative to the storm intensity did not change in a measurable way in the 1980s and 1990s. This finding suggests that human influence did not dramatically increase or decrease the sedimentation process.

SFRR Sedimentation



Sedimentation is reducing SFRR's water storage capacity.

What is Sedimentation?

Sedimentation is the process by which soil is transported from one place (e.g. a stream bank on the Mechums River, a farm field, or new development) and deposited somewhere else (e.g. the SFRR). The moving water of the streams is able to carry a large amount of sediment, particularly during storms. As the water slows in the reservoir, much of the sediment settles. Sediment in the reservoir displaces water the reservoir otherwise would store.

Sediment originates from two chief sources: the landscape and the streambank. Sedimentation is a natural process accelerated by human activities. Rain falling on the landscape loosens and transports sediment. The process is accelerated when protective vegetation is cleared from the land. High stream flows from storms erode stream banks (which may be made of previously deposited sediment). Streambank erosion is accelerated when trees and shrubs that naturally stabilize the banks are removed and when livestock trample the banks. The process also is accelerated when the ability of soils to absorb water is impeded by paving and compaction of soil through agriculture and suburban development. As the watershed absorbs less water, more stormwater goes directly to streams, contributing to high flows and erosion.

The sedimentation problem is complex and hard to manage. Though both landscape and stream bank erosion are accelerated by human activities, the amount of sediment attributable to each type is poorly understood, especially in a watershed as large and diverse as the SFRR's. Most existing sedimentation reduction efforts focus on the landscape source, but in some watersheds around the country the stream bank source has produced two-thirds or more of the sedimentation. Some evidence exists that sediment in stream valleys today was deposited as a result of intense logging and farming in the 18th, 19th, and early 20th Centuries. Still, there are measures that might help reduce sedimentation including more extensive vegetated stream buffers, stream bank stabilization, sediment removal, and landscape management practices on farms, forest, and developed areas.

1977 Clean Water Act amendments tighten restrictions on discharge of pollutants (particularly toxins).

1979 Watershed Management Plan developed by a County/City/regional committee.

Position of Watershed Management Official created (now Watershed Manager).

1980 Albemarle Supervisors finalize comprehensive down-zoning of rural areas including SFRR Watershed.

Down-zoning appealed to Virginia Supreme Court. Albemarle prevails.

1988 Crozet interceptor goes on line removing Crozet's residential and commercial sewage from the SFRR Watershed.

Hydro-power plant installed at SFRR dam.

Virginia bans phosphates in detergents.

1991 Albemarle becomes first non-Tidewater locality to adopt provisions of the Chesapeake Bay Preservation Act to protect stream buffers (Water Resource Protection Areas Ordinance).

1993 Lickinghole Basin, a regional stormwater basin serving Crozet, completed.

1998 Albemarle develops a new Water Protection Ordinance combining and improving previously developed erosion and sedimentation, stormwater, and stream buffer laws.

2002 RWSA adopts environmental policy.

RWSA Board approves new water supply plan. Continued use of SFRR is central to the plan.

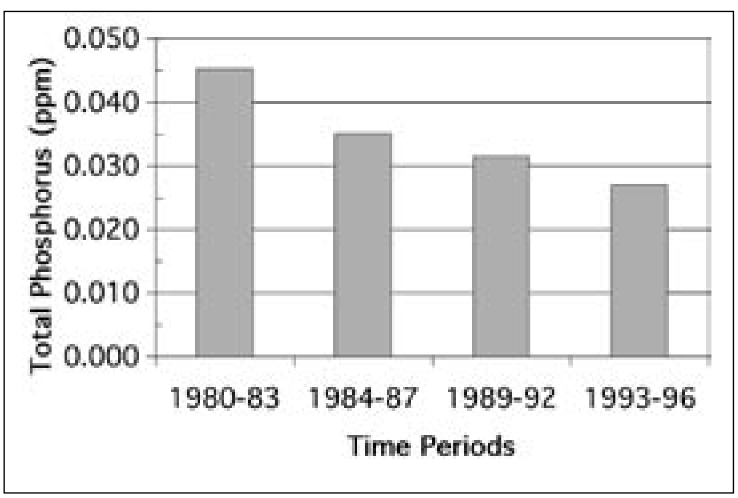
What is over-enrichment?

The term over-enrichment (or eutrophication) describes an ecological process. Nutrients, primarily phosphorus and nitrogen, are food for algae drifting in the reservoir. With increased food, the algae population increases. A large algae population can create problems. During the day, algae both release oxygen (via photosynthesis) and consume it (via respiration). During the night they only consume oxygen. Large algae populations can lead to low oxygen concentrations at night. (SFRR fish kills in the early 1970s occurred at night.) Furthermore, when floating algae die, they sink to the bottom where they are eaten by bacteria. Bacteria consume oxygen (also via respiration). The result can be very low oxygen conditions in the reservoir, particularly at lower depths that are isolated from the air.

Several issues are associated with high algae concentrations. The low oxygen conditions can foster chemical reactions that change iron and manganese from forms that settle on the bottom to forms that dissolve in the water column. The resuspension of the iron and manganese can lead to problems with the taste, odor, and appearance of the water. (These aesthetic problems are not associated with health safety problems.) Also, certain types of algae cause taste and odor problems or clog filters in the water treatment plant. These algae are favored by excess nutrients. Most importantly, high levels of organic matter in water, such as algae, can lead to production of undesirable chemicals as the water is disinfected. Reducing nutrients, and thus algae, can help prevent this problem.

Sediment reduction strategies and goals will need to be refined by developing a greater understanding of the various sediment sources and their relative importance. Enhancement of stream buffer vegetation is a strategy at hand immediately. Traditional sediment control strategies such as erosion and sediment control at construction sites and agricultural management practices will continue to be important tools.

Phosphorus in the SFRR



Concentrations of phosphorus, a key nutrient involved on over-enrichment, were reduced by 40% in the 1980s and early 1990s.

Enrichment and Related Issues

Since monitoring began in the early 1980s, phosphorus concentrations in the reservoir are clearly down (about 40%). Nitrogen concentrations appear to be down as well. The main source of this improvement was probably the Crozet sewage interceptor installed in 1988. Additional likely factors were a gradual decline in row crop agriculture, a state-wide ban on phosphate detergents, installation of agricultural best management practices (BMPs), and construction of the Lickinghole Creek Stormwater Basin. The nutrient reductions in the 1980s and 1990s may have built upon other, unmeasured reservoir improvements in the middle and late 1970s that resulted from the federal Clean Water Act and reservoir maturation. Since the late 1980s, operation of the hydropower plant or some other factor may have led to increases in the algae community in spite of the phosphorus reductions. (See full report for details.) If algae have increased, the issue has not translated into significant water treatment problems. Had the phosphorus reductions not occurred, it is possible that the algae problems that took place in the 1960s, 70s, and early 80s would have reappeared.

✧ Toxins, Metals, and Pathogens

The initial study of the SFRR reported in 1977 that there were no significant problems with metals or other potential toxins in the reservoir. There is no reason to believe there has been any change in this status. The finished water is comprehensively analyzed annually and is meeting all standards. Despite little evidence of problems, this issue should always be monitored. Similarly, the finished water is free of problems with pathogens. However, efforts should continue to minimize pathogens in the raw water.

✧ Other Issues

Several specific issues could be addressed in future watershed management efforts. Among these are the potential impact of septic systems on drinking water, risks associated with the possible US 29 western bypass, livestock access to the reservoir and its tributaries, and minimizing chlorination by-products (that are related to eutrophication). Strategies might be considered to reduce the impacts of both the Sugar Hollow Dam and the South Fork Rivanna Dam on downstream ecosystems without threatening water supply. County stormwater policies regarding the regional Lickinghole Basin may need to be revisited. The land application of biosolids is another up-and-coming issue in Virginia.

✧ Overall

The SFRR Watershed is a microcosm of water quality in the United States. Significant gains have been made with point source pollution. The effort to reduce nonpoint source pollution has proven more difficult. It is almost as difficult to study nonpoint source pollution as it is to control it. Data on development activity and on chloride concentrations suggest that nonpoint source pollution will continue to be a management challenge. Since 1988, nonpoint source pollution has been the main target of watershed management. It will continue to be the thrust of both management and monitoring, particularly in light of the fact that sedimentation is almost exclusively a nonpoint source problem.

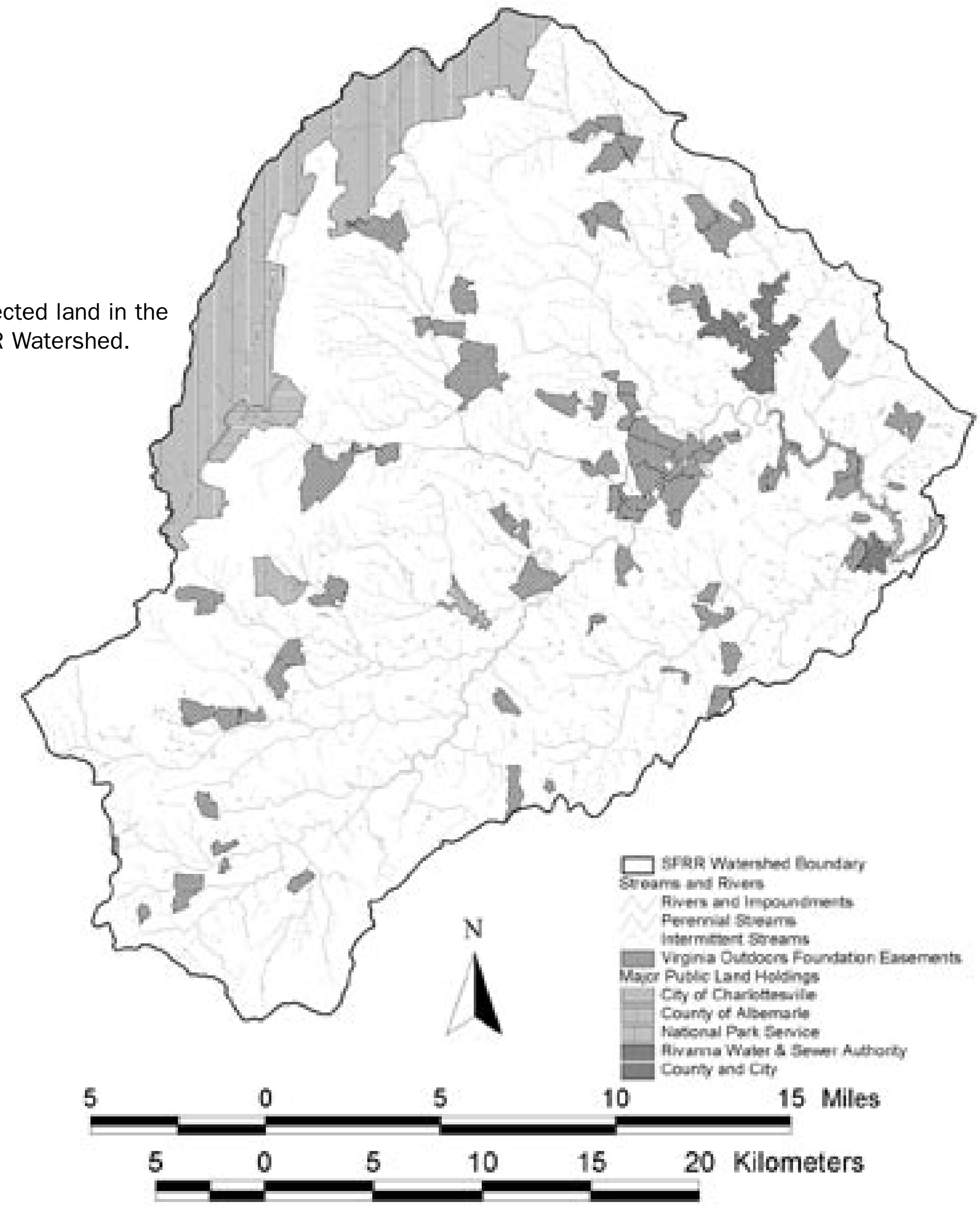
What are point and nonpoint source pollution?

The terms point and nonpoint source are used frequently in regard to water pollution. Point source pollution is associated with a pipe. Examples include sewage treatment plants and industrial discharges. Most major point source pollution sources are regulated under a state permit system. Nonpoint or diffuse sources of pollution come off the wider landscape and not through a pipe. Examples include urban, suburban, farm, and forestry runoff. Few nonpoint pollution sources are currently regulated.

Possible Strategies for a New Watershed Management Plan

Following is a menu of options for consideration in updating the watershed management plan. Not everything on the list could or should be done. The items on the list must be evaluated based on effectiveness, cost, feasibility, and other factors. However, the list is a starting point.

Protected land in the SFRR Watershed.



- Expand on the current partnership with the Thomas Jefferson Soil and Water Conservation District to make progress on this shared mission. Consider providing local/utility funds to enhance TJSWCD efforts focused on SFRR problems.

- Promote riparian buffers
  - – Encourage farmers in the SFRR Watershed to enter the Conservation Reserve Enhancement Program (CREP) and other agricultural cost-share programs.
  - – Add to federal and state funds with local/utility funds to bring more farmers into the program.
  - – Use local/utility funds to purchase riparian easements, with the help of the TJSWCD, for the expected life of the reservoir.
  - – Increase enforcement of the Albemarle County riparian buffer ordinance on previously developed land. Current enforcement focuses on new development and complaints.
  - – Increase riparian buffer education efforts.
  - – Require buffers by those who benefit from County programs such as ag/forestral districts, land use assessment, and the Acquisition of Conservation Easements (ACE) program.

- Maximize forest throughout the watershed.

- Launch a major research effort into the sources of and appropriate mitigation strategies for sedimentation. Outside sources would be used, but a significant local commitment would be essential.

- Work with agricultural agencies to encourage other best management practices (BMPs) that reduce sediment runoff.

- Conduct a visual assessment of erosion and other problems in watershed streams.

- Carry out stream bank stabilization at critical locations.

- Investigate forebays to trap sediment entering SFRR.

- Hire more Erosion and Sediment (E&S) Control inspectors in Albemarle County to increase enforcement of E&S law in the SFRR Watershed. (Currently there are three inspectors, two plan reviewers, and a supervisor in the E&S program.)

- Make the Albemarle County stormwater ordinance stricter in the SFRR Watershed and more directed at sediment.

- Develop a reservoir sediment load model as a management/regulatory tool.

- Consider the benefits and harms of private ponds. Such ponds can trap sediment but they also break up stream networks, destroy wetlands, and reduce water quality in several ways. The question of whether the benefits of ponds outweigh the harm should be addressed to decide whether to promote or discourage them.

✧ Nutrients / Enrichment

- Promote riparian buffers (including the same possibilities listed for sediment).

- Maximize forest throughout the watershed.

- Support agricultural agencies (TJSWCD, Natural Resource Conservation Service {NRCS}, Cooperative Extension Service, etc.) in promoting best management practices that reduce nutrients in runoff. Support could come in a financial form or through staff coordination.

- Work to prevent and prepare for an increase in septic system failures.

  – Assess the actual risk from septic system failures to calibrate the response. The threat to groundwater supplies may be greater than that to surface water supplies at least initially.

  – Work with the Virginia Department of Health (VDH) to educate the public regarding proper maintenance.

  – Work with VDH to apply enhanced treatment technology to problems when necessary. Adopt necessary zoning ordinance language.

  – Work with VDH to provide financial support for low income families with failing septic systems or in need of assistance to carry out maintenance.

  – Intervene to help develop solutions when an entire community faces a problem.

  – Consider an ordinance to assure proper maintenance and regular pumping.

- Prepare for increased land application of human biosolids and/or animal wastes.

  – Assure that phosphorus is not over-applied.

  – Consider a biosolids ordinance.

- Develop a pollutant load model as a management/ regulatory tool.

✧ Pathogens and Toxins

- Initiate more outreach to homeowners on monitoring and maintenance of fuel oil tanks and the use of chemicals.

- Stay apprised of Virginia Department of Environmental Quality (VDEQ) efforts (such as the Leaking Underground Storage Tank and Virginia Pollutant Discharge Elimination System programs) in the SFRR Watershed.

- Get involved with TMDLs in the Rivanna River Watershed in the interest of minimizing fecal coliform counts.

- Work with VDH to educate the public regarding proper use and maintenance of septic systems.

- Educate the public on other aspects of pollution prevention (involving household hazardous waste, etc).

- Become more familiar with agricultural and residential uses of potentially hazardous chemicals.

- Work with agricultural agencies (TJSWCD, NRCS, Cooperative Extension Service, etc.) to assure proper use and storage of potentially hazardous chemicals on farms.

- Perform monitoring for metals and other potentially hazardous materials as needed.

- Prepare (as described above) for increased application of biosolids.

- Encourage vegetated buffers on reservoirs, etc. to make them less hospitable to geese.

✧ Other Issues

- Determine if the hydraulic conditions produced by the hydropower plant are allowing more time for algae nutrient consumption and growth, resulting in larger algae populations, and if those populations are causing problems. If so, carry out a cost benefit analysis of shutting down the power plant seasonally to reduce algae concentrations versus other methods of reducing disinfection by-products. Algae provide some of the organic material that reacts with chlorine to produce the by-products.

- As water quantity modifications to the SFRR are being designed, investigate whether measures to improve the water quality of the tailwater can be included.

- RWSA, County, ACSA, and City could work with Virginia Department of Game and Inland Fisheries (VDGIF) to determine the best way to manage the voluntary release of water to the Moormans River below Sugar Hollow Reservoir and below the SFRR dam in a way that does not threaten the water supply.

- Address concerns regarding the possible US 29 Western Bypass.

- Use the Water Protection Ordinance to prevent development of the SFRR shoreline. Clarify policies that support the ordinance and educate riparian landowners.

- Work with the Albemarle County Department of Parks and Recreation, VDGIF, rowing groups and others to assure the recreation activities and facilities do not pose a risk to the SFRR.

- Consider abandoning the Lickinghole Basin pro rata share policy for the on-site BMP policy in place in most of the County, or consider use of subregional BMPs in the Crozet Designated Growth Area.

- Develop a zebra mussel education program and possible boat washing facilities and requirements.

- Determine a strategy for eliminating cows from the reservoir that is fair to the farmers using the reservoir.

✧ Watershed Resilience

- Maximize forest throughout the watershed.

- Minimize fragmentation of the land and conversion of land to residential/commercial land use.

- Encourage farming practices that minimize impact to water quality.

- Promote riparian buffers (including the same possibilities listed for sediment).

- Protect land for water supply protection through Albemarle County's ACE program, the TJSWCD riparian easement program, the Virginia Outdoors Foundation, and other programs.

- Continue and expand efforts to implement the RWSA Board policy for managing the Buck Mountain Creek holdings, particularly in a way that protects the SFRR.

For a copy of the full draft report please visit
www.rivanna.org or **www.albemarle.org**

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